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AIR MONITORING QUALITY ASSURANCE

VOLUME V

AUDIT PROCEDURES FOR AIR QUALITY MONITORING

APPENDIX R

PERFORMANCE AUDIT PROCEDURES FOR CARBONYL SAMPLERS

MONITORING AND LABORATORY DIVISION

MAY 2002

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PERFORMANCE AUDIT PROCEDURES FOR CARBONYL SAMPLERS

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R.1.0 GENERAL INFORMATION

R.1.0.l AUDITING PROCEDURES

The primary goal of an auditing program is to identify system errors that may result in suspect or invalid data. Accurate assessment of the carbonyl sampling system can only be achieved by conducting an audit under the following guidelines:

1. Without special preparation or adjustment of the system to be audited.

2. By an individual with a thorough knowledge of the instrument or process being evaluated, but not by the routine operator.

3. With accurate calibrated National Institute of Standards Technology (NIST) traceable transfer standards that are completely independent of those used in routine calibration.

4. With complete documentation of audit data for submission to the operating agency. Audit information includes, but is not limited to, types of instruments and audit transfer standards, model and serial numbers, transfer standard traceability, calibration information, and collected audit data.

The audit procedures described here evaluate three distinct sampling systems within the carbonyl sampler. Each sampling system's flow rate is calculated and compared to a true flow rate as measured from the audit instrument.

An independent observer should be present, preferably the routine operator of the sampling equipment. This practice not only contributes to the integrity of the audit, but also allows the operator to offer any explanations and information that will help the auditor to determine the cause of discrepancies between measured audit data and the sampling equipment response.

R.1.0.2 FLOW RATE PERFORMANCE AUDITS OF THE CARBONYL SAMPLER

Audit procedures presented here are specific to commercially available carbonyl samplers which operate at an actual total flow rate of 100 to 1500 cc/min (see Figures R.1.0.1 through R.1.0.5). Audit techniques may vary between different models of samplers due to differences in the instrument's programming and configuration.

The carbonyl sampler flow rate audit method involves using a calibrated transfer standard mass flow meter (MFM). This equipment is NIST traceable and calibrated once a quarter with the relative standard deviation within 1.0% of the last two calibrations.

Since accurate measurement of carbonyl compounds is dependent upon flow rates under actual conditions, the auditor must also audit in terms of actual conditions. If the audit transfer standard's calibration data have been corrected to EPA reference conditions (298°K, 760 mm Hg), a conversion must be calculated to adjust the SLPM flow rate (Qstd) to an actual LPM flow rate (Qa). The audit MFM calibration relationship is expressed in terms of standard volumetric flow rate (Qstd), as indicated by the audit MFM; these units are SLPM (standard liters per minute).

R.l.0.3 AUDIT APPARATUS

The audit transfer standard must be certified against a primary standard traceable to NIST.

1. The following equipment are needed to perform an audit of the carbonyl sampler:

   a. Certified (NIST traceable) transfer standard MFMs (0-500 sccm and 0-3 SLPM) with the most recent calibration reports.

   b. 1/4 inch Teflon tubing (1 foot long) with swage lok adapter on one end to connect to the transfer standard outlet.

   c. 3/8 inch (inside diameter) Tygon tubing (3-feet long).

   d. Carbonyl cartridges. The cartridges are prepacked silica gel cartridges that are coated with an acidified dinitrophylhydrozine (DNPH) reagent.

   e. A thermometer capable of accurately measuring temperature over the range of -20°C to +60°C and accurate to the nearest 1°C. It must be referenced to a NIST or American Society for Testing and Materials (ASTM) thermometer and checked annually. The thermometer should be within ±2°C on the annual check.

   f. A barometer capable of accurately measuring ambient pressure to the nearest millimeter mercury (mm Hg) over the range of 500 to 800 mm Hg. The barometer must be referenced within ±5 mm Hg of a barometer of known accuracy at least annually.

   g. An adjustable wrench (6 inch).

2. Also needed for the audit is an audit data worksheet used to document audit information (see Figure R.1.0.6, QA Audit Carbonyl Sampler

Worksheet). This information includes, but is not limited to, sampler and audit transfer standard type, model and serial numbers, transfer standard traceability and calibration information, ambient temperature and pressure conditions, and collected audit data.

R.1.0.4 AUDIT DATA CALCULATIONS

1. Calculate each channel's standard flow rates using the transfer standard MFM calibration data. (See Equation 1 below.)

   Standard Flow Qstd (SLPM) = Qind x m ± i (Equa. 1)

   Where: Qstd = Flow rate at standard temperature and pressure, SLPM

   Qind = The transfer standard reading (TS)

   m = Slope

   i = Intercept

   NOTE: It may be necessary to correct audit flow rates, if they are in standard conditions, to actual conditions. (See Equation 2 below.)

   Qa (LPM) = Qstd [(Ta/298. 15)(760/Pa)] (Equa. 2)

   Where: Qa = Flow rate at actual conditions, LPM

   Qstd = Standard flow rate at standard temperature and pressure (298.15°K, 760mm Hg), SLPM

   Ta = ambient temperature, °K

   P = ambient barometric pressure, mm Hg

   Using Equation 2, calculate and record the transfer standard mass flow rate Qa (Audit) on the audit data worksheet.

2. Ask the operator to calculate (using the sampler's calibration relationship) the corresponding sampler standard flow rates and record these values under the Sampler Calibration Data section and the Audit Data section, as appropriate, on the audit data worksheet. (See Equation 1 above.)

3. Using Equation 2 above, calculate and record the Qa (Sampler) on the audit data worksheet.

4. Determine the percent difference between the sampler indicated flow rates and the audit measured flow rates. (See Equation 3 below.)

$$\text{Audit \% Difference} = \frac{\text{Qa (Sampler)} - \text{Qa (Audit)}}{\text{Qa (Audit)}} (100) \quad \text{(Equa. 3)}$$

5. Record percent differences. Any deviation greater than ±7% will require an investigation or a recalibration. Differences exceeding ±10% require an Air Quality Data Action (AQDA) request to be issued. Upon investigation, the invalidation or correction of all data from the last calibration forward or known date of change (to be determined by the reporting agency) may result.

R.1.0.5 AUDIT DATA REPORTING

The operating agency should be given a copy of the preliminary audit results when the audit is completed. The preliminary data should never be used to make monitoring system adjustments. A post audit verification of audit equipment and data is essential before inferences can be drawn regarding the sampler's performance. An auditor should be able to support audit data with quarterly pre- or post-audit equipment verification documentation. (See Figure R.1.0.7 for a sample of the preliminary audit results.)

Final verified audit data should be submitted to the operating agency as soon as possible. Delays may result in data loss; a sampler out of audit limits is also out of calibration limits, and the data collected may be invalid. If a sampler exhibits unsatisfactory agreement with the verified audit results (audit differences exceed ±7%), a calibration should be performed before the next run day.

R.l.0.6 PERFORMANCE AUDIT FREQUENCY

For Photochemical Assessment Monitoring Stations (PAMS), audit the flow rate of each sampler per monitoring network during the PAMS season (July through October). Each sampler will be audited at least once per year.

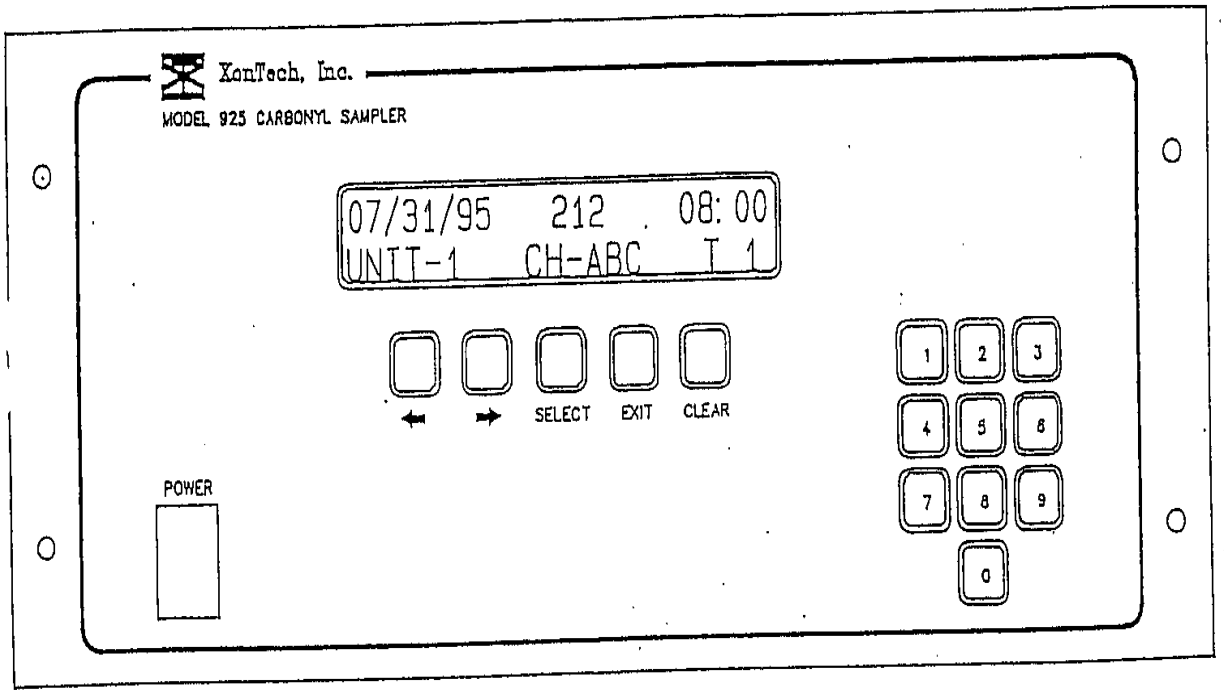

Figure R.1.0.1
Carbonyl Sampler Control Module Front Panel (XonTech 925)

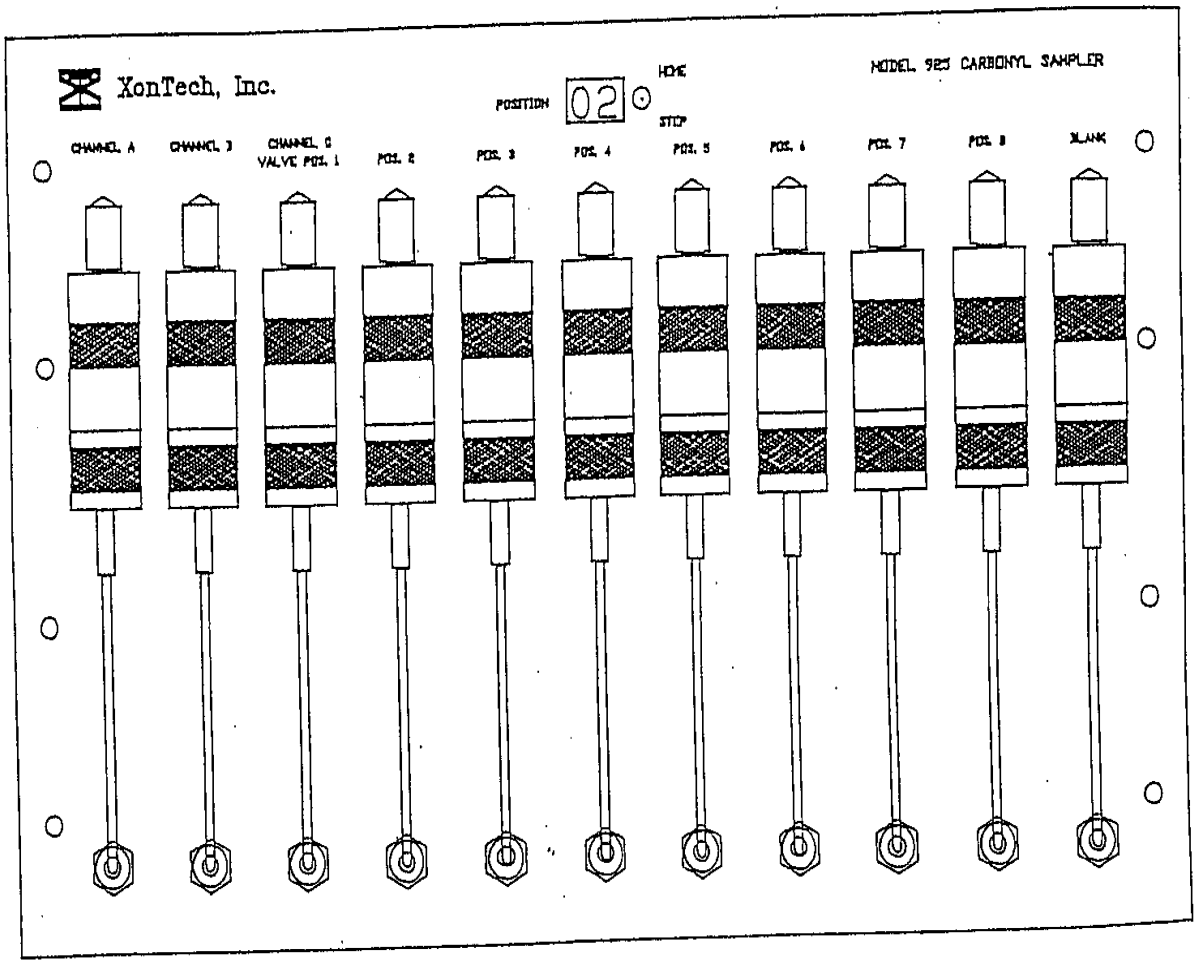

Figure R.1.0.2
Carbonyl Sampler Tube Unit Front Panel (XonTech 925)

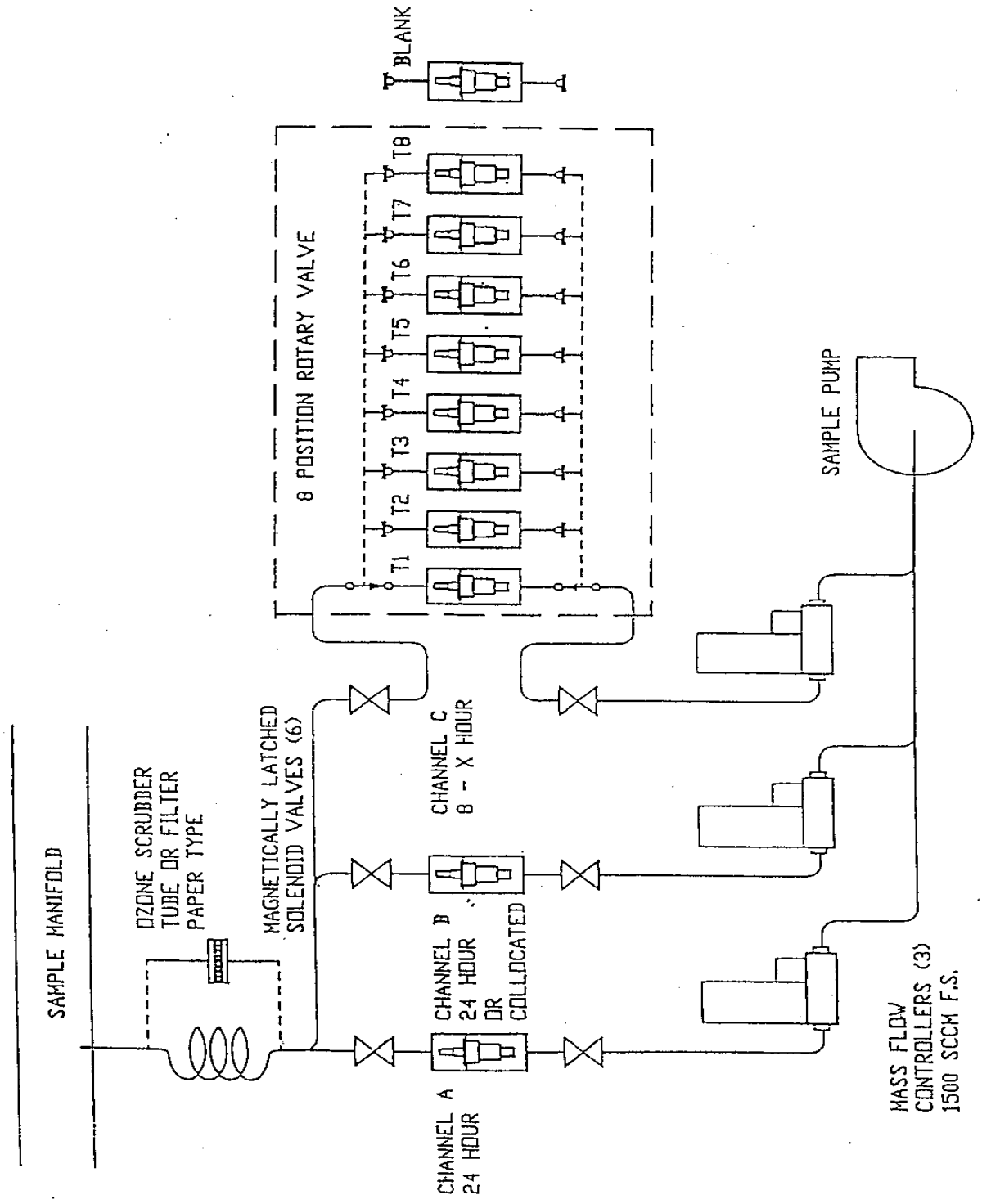

Figure R.1.0.3
Carbonyl Sampler Flow Diagram (XonTech 925)

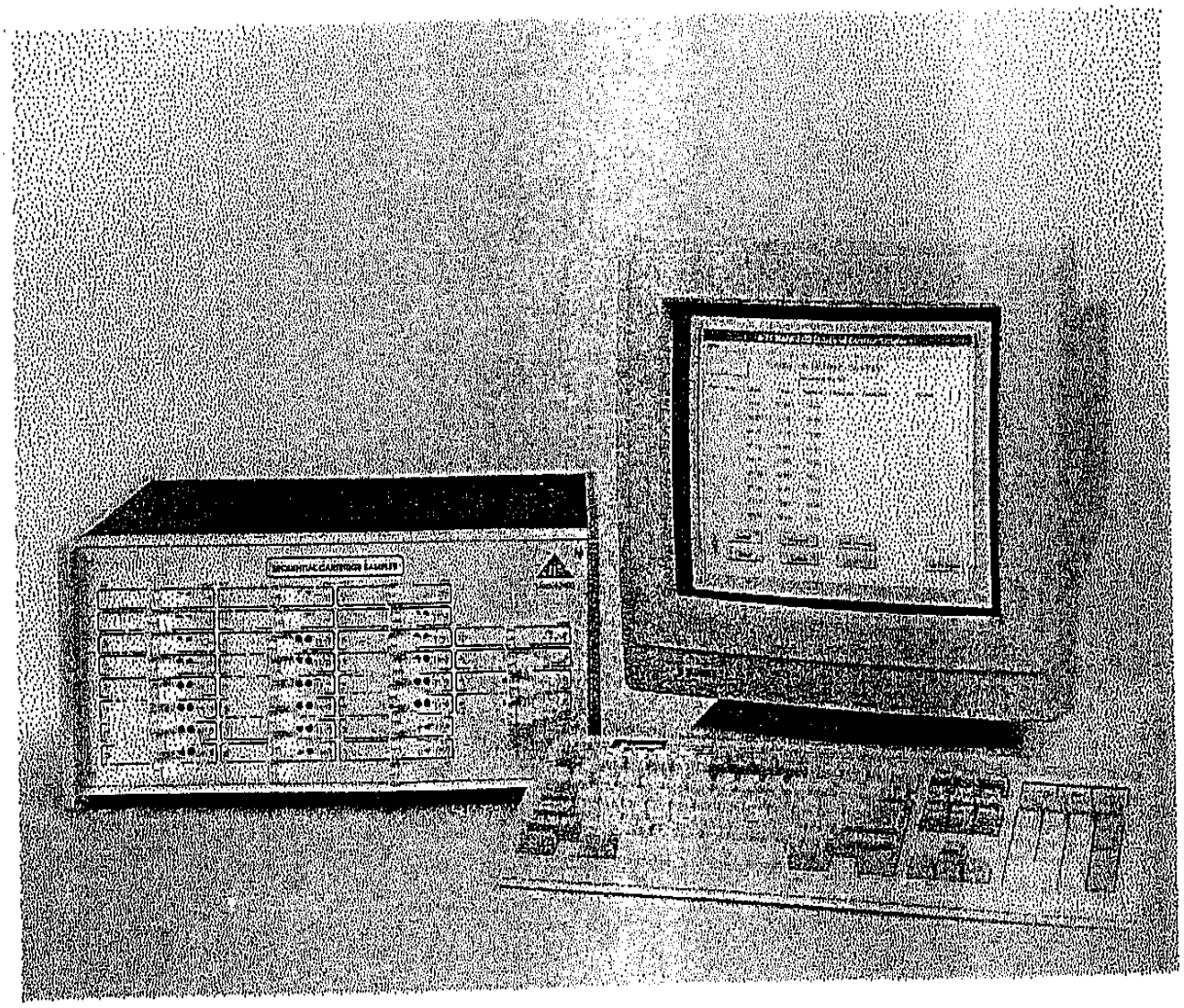

Figure R.1.0.4
Carbonyl Sampler (ATEC Model 2400)

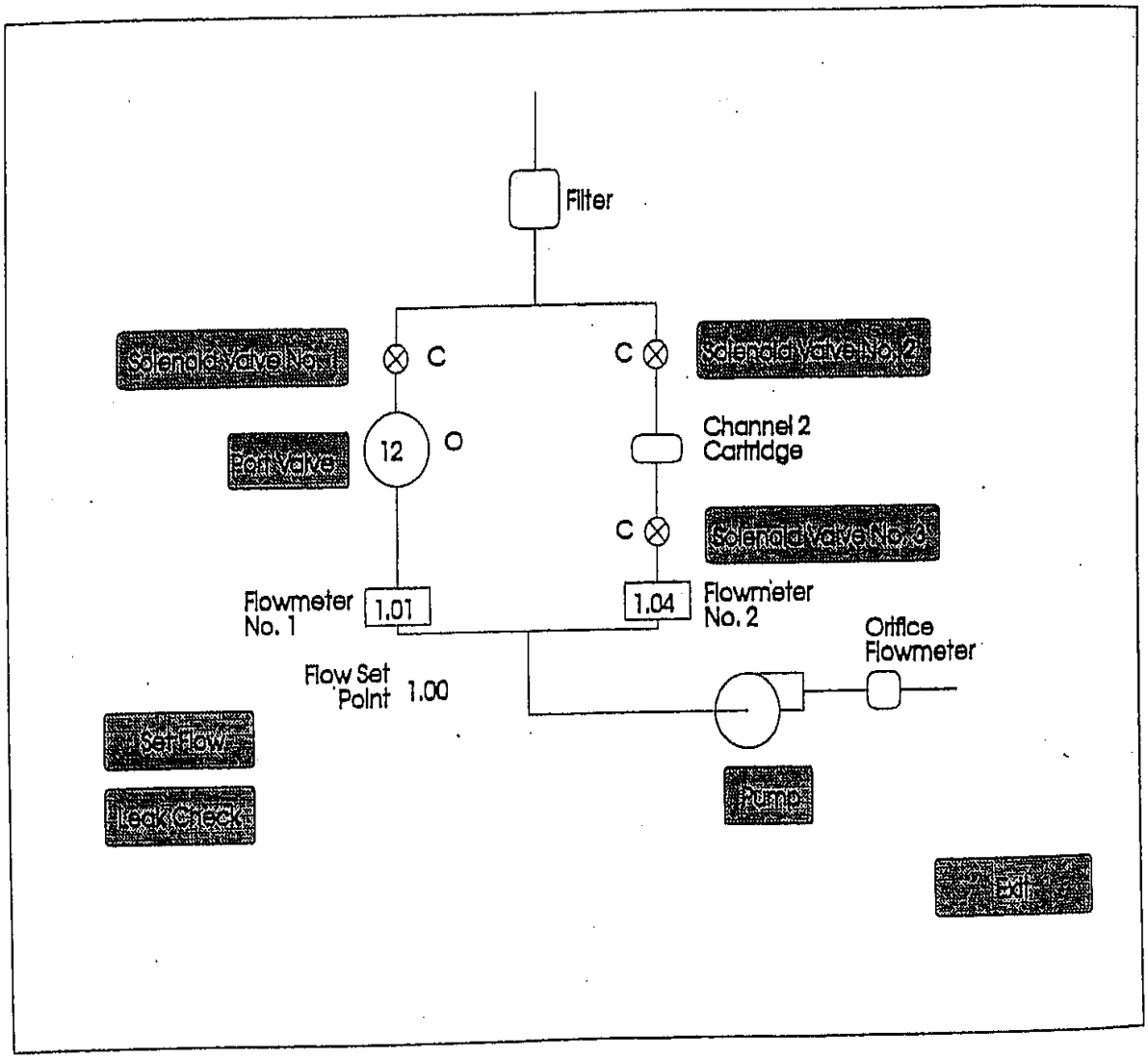

Figure R.1.0.5
Carbonyl Sampler Flow Schematic (ATEC Model 2400)

QA AUDIT WORKSHEET
XONTECH 925 CARBONYL SAMPLER

Site Name: _____ Site Number _____ Date: _____

Address: _____ Agency: _____

Technician: _____ Auditors: _____

Quarter: 1[ ] 2[ ] 3[ ] 4[ ] Standards Version: _____ Year: _____

Sampler Information

Make and Model: _____ Channel Audited: _____

Serial/ID#: _____ Tube # Audited: _____

Cal. Date: _____

Cal. Equipment Cert. Date: _____ Sampler Flow Rate: _____

Flow Audit Information

Audit Point	Sampler Flow	Audit MFM Response
Channel A		
Channel B		
Channel C		

Barometer Information	
ID#:	
Initial Reading	Final Reading

Carbonyl Audit Information

Dilution Unit Information
Make/Model:
ID#:
Cal. Date:

Pure Air Unit Information
Make:
Model:
ID#:

Purge and Sample Times	Start	Stop
Zero Air Purge (2 hours)		
Audit Gas Purge (30 minutes)		
Audit Gas Sample Period (3 hours)		

Audit Cylinder Information		
ID#:		
	Initial	Final
Gauge Pressure		

Environics Target Flows	
Port #1	ccm
Port #3	ccm

Environics Actual Flows	
Port #1	ccm
Port #3	ccm

COMMENTS: _____

Figure R.1.0.6
QA Audit Carbonyl Sampler Worksheet

Quality Assurance Carbonyl Flow Audit Report

Station/Van Audit Data & Results

Station Data		Van Data			
Station Flows (SLPM)	Channel	Display Reading	Indicated Flows (LPM)	Actual Flows (LPM)	**Percent Difference**
0.298	A	56.600	0.295	0.287	***2.8%***
0.298	B	56.600	0.295	0.287	***2.8%***
0.000	C	0.000	0.000	0.000	***0.0%***

Audit Calculations

Actual Flow = (MFM Slope * Display Reading + MFM Intercept)*(Temp in Kelvin/298.15)*(760/Barometric Pressure)

Indicated Flow = (Station Flow)*(Temp in Kelvin/298.15)*(760/Barometric Pressure)

Channel	MFM Slope	MFM Intercept	Barometric Pressure in mmhg	768.00
A	0.0051	0.0018	Temperature in Kelvin	298.15
B	0.0051	0.0018		
C	0.0000	0.0000		

Instrument/AIRS Information

ARB Number	80123	AIRS Number	060730006
Audit Date	11/08/2001	Instrument Manf.	XONTECH
Version	0	Model	925
Quarter	4	Serial Number	250643
Van	D	Last Calibration	/ /

General Comments

* Calibration date and calibration equipment certification date unavailable.

Figure R.1.0.7
Preliminary Audit Results Printout

R.2.0 GENERAL OPERATING PROCEDURES (XONTECH 925)

R.2.0.1 LEAK CHECK PROCEDURES

During the leak test, all solenoid valves upstream and down stream of the cartridges are checked. First, a zero check is initiated for channels A, B, and C. The zero check checks for leaks in the mass flow controllers. During the zero check, the voltage offsets are determined and subtracted from the channel readings for the remaining leak check sequences. The leak test and performance audit should be performed with the cartridges in place. A leak test is initiated using the following procedure (see Figure R.1.0.1 for a layout of the control panel).

NOTE: Sampler's equipped with multiple tube units will need to have each tube unit leak checked and audited.

1. Install carbonyl cartridges into channels A, B, and C by disconnecting the cartridge sampling lines and unscrewing the cartridge holders (see Figures R.1.0.2 and R.1.0.3). Prior to installing the cartridges, remove the caps located at each end of the cartridge. Additionally, verify the o-ring inside the cartridge holders are in place.

   NOTE: When handling the cartridges, use the green laboratory rubber gloves.

2. Press EXIT twice to return to the main screen #1 (Default Screen). It should read "Idle".

3. Move to the main screen #7 (Leak Check Screen) by pressing the RIGHT ARROW 6 times.

4. Press SELECT. The Unit # will be underlined.

5. Press SELECT. The Unit 1 underline blinks.

6. Press SELECT. Enter the tube unit ID# by pressing the arrow buttons.

7. Press EXIT. Exit will prompt "Begin Check? - N".

8. Press SELECT. "N" will blink. Press RIGHT ARROW to display "Y".

9. Press EXIT. Leak check will initiate.

   NOTE: The leak check will run automatically. During the leak check, if a leak is evident, trouble shooting can be performed to repair the leak.

10. At the completion of the leak check, return to the main screen #1 (Default Screen) by pressing EXIT twice.

    NOTE: In the event the instrument does not pass the leak check test, report the failure to the station technician and determine if the problem can be repaired.

R.2.0.2 TOTAL FLOW RATE AUDIT PROCEDURES

1. Prior to conducting the total flow audit, print a copy of the instrument's status (if the unit has printer capabilities). From the main screen #1 (Default Screen), press SELECT. Press RIGHT ARROW until "Print Full Report" is displayed. Press SELECT and RIGHT ARROW to change to "Y". Press EXIT. The report will print. The print out will provide the auditor with a record of the instrument's settings. Once the report has printed, press Exit again.

2. Energize the transfer standard MFM and allow a warm up time of at least *5* minutes.

   NOTE: Ensure that the transfer standard MFM display selector switch is in the proper position. The transfer standard should also be shaded from direct sunlight to prevent heating the temperature element inside the MFMs.

3. Connect the one-foot section of Teflon tubing to the transfer standard outlet (0 to 3 LPM).

4. Attach one end of the Tygon tubing to the one-foot section of Teflon tubing and the other end to the carbonyl sampler inlet line.

   NOTE: The sampler inlet line may be connected to a manifold. If so, disconnect from the manifold and attach to Tygon tubing. The sampler may also have its own sample line. If so, the Tygon tubing should be attached at the probe inlet (roof) if possible. Otherwise, connect the Tygon tubing at the sampler inlet port. Record the hook-up location on the audit results form.

5. On the sampler control module, move from main screen #1 (Default Screen) to main screen #6 (Schedule Unit Display). The screen displays the tube unit #, start date, start time, duration and group # for each channel.

NOTE: XonTech has updated the samplers programming to include a manual operation module. If the sampler has the updated programming, skip to step #13, otherwise continue with step #6.

6. Press SELECT. Unit # will be underlined.

7. Press SELECT. Unit # will blink. Enter the required unit # using the arrow key.

8. Press EXIT. Exit to the next item (Channel A).

9. Press the RIGHT ARROW to advance to each item that may require changes (Channel, Start Date, Start Time, Duration, Group).

   NOTE: The time and duration should be entered in military time and the group number should be 1.

   a. Once the item has been selected press SELECT. The item will blink to indicate a change can be made.

   b. Key in the change by using the keypad or arrow buttons and press EXIT.

   c. Follow this sequence for channels A, B, and C.

   NOTE: The sample duration should be set to 10 minutes to allow ample warm up time. The sample time should be set to follow the previous channel's sample duration. For example, channel A's settings would be Start Date - 06/28/96, Start Time - 09:00, Duration - 00:10, Group 1; channel B's settings would be Start Date - 06/28/96, Start Time - 09:10, Duration - 00:10, Group 1; and channels C's settings would be Start Date - 06/28/96, Start Time - 09:20, Duration - 00:10, Group 1.

10. Press EXIT twice to return main screen #1.

11. Press RIGHT ARROW once. This screen (Main Screen #2) displays the flow rate of channels A, B, and C.

12. The sampler will operate on channels A, B, and C for the programmed times and durations. Record the flow rates as indicated on the sampler display as QA Sampler on the audit data worksheet (see Figure R.1.0.6).

    NOTE: After completing step #12, skip to step #23.

13. On the sampler control module, move from main screen #1 (Default Screen) to main screen #7 (Leak Check). Press SELECT and the LEFT ARROW key. The screen displays the following:

    Manual Run Unit 1

    CH-A Start? N

14. The display shows the number "1" underlined. Press SELECT to change this number. If checking unit #1, a "1" should be underlined. Press EXIT.

15. The display shows "CH-A" underlined. To change the Channel to be checked, press SELECT. CH-A will blink. Use the arrow keys to change the channel selection. Once the appropriate channel is selected, press EXIT.

16. The N following "start?" will now be underlined. Press SELECT. The N will begin to blink. Use the arrow keys to change to Y. Press EXIT to start.

17. Sampler is now running on the selected channel.

18. Press EXIT. The display should read "Leak Check". Use the arrow keys to get to the flow display screen.

19. After flow readings have been taken, return to the leak check screen using the arrow keys. Press SELECT.

20. Screen display will read the following:

    Manual Run Unit 1
    CH-A Stop? N

    The "N" will be underlined. Press SELECT. The "N" will begin blinking. Use the arrow keys to change "N" to "Y". Press EXIT. The unit will shut off.

21. Repeat steps 15 through 20 to check flow rates of channels B & C.

22. Press EXIT twice to return to the main screen.

23. Record the transfer standard (TS) MFM readings on the audit data worksheet under the total flow column. (This will be used as Qind in Equation 1 of Section R.1.0.4 of this procedure.)

24. Complete the top half of the audit data worksheet with the required information, including ambient temperature (Ta), in degrees celsius, and ambient barometric pressure (Pa), in mm Hg. Under Sampler Calibration Data, record the calibration information for each mass flow controller.

R.2.0.3 POST AUDIT CONFIGURATION

1. Disconnect the audit device from the sampler and return the sampling system to its normal operating condition.

2. Reprogram the operating variables (Unit #, Start Date, Start Time, Duration, Group #) to their normal operating positions (see Section R.2.0.2). These are indicated on the report that was printed prior to conducting the total flow audit.

R.2.1 GENERAL OPERATING PROCEDURES (ATEC MODEL 2400)

R.2.1.1 LEAK CHECK PROCEDURES

1. Install carbonyl cartridges into channel 1, port 1 and channel 2 by disconnecting the cartridge sampling lines and opening the cartridge holder. Prior to installing the cartridges, remove the caps located at each end of the cartridge.

2. From the main screen (see Figure R.2.1.1) key the manual button.

3. From the manual mode screen (see Figure R.2.1.2) perform a manual leak test of Channel 1, port 1 and Channel 2.

4. Select port I on the rotary valve diagram. Start pump by keying the pump button. Verify the inlet/outlet values are closed for both flow controllers. If they are open, close the valves by keying the appropriate inlet/outlet valve button(s).

5. Read and record flow rates in the comments section of the audit data worksheet as leak test results. (See Figure R.1.0.6)

   NOTE: If the sampler indicates a leak is present, check the cartridge holders. If the leak is still indicated, consult with the site operator before proceeding.

R.2.1.2 TOTAL FLOW RATE AUDIT PROCEDURES

1. After the leak test readings have been recorded, open channel 1 mass flow controller by keying the inlet/outlet valve buttons.

2. After five minutes, record the sampler flow rate under QA sampler on the audit data worksheet.

3. Record the transfer standard MFM reading on the audit data worksheet under the total flow column. (This will be used as Qind in Equation 1 of Section R.1.0.4 of this procedure.)

4. Close channel 1 mass flow controllers by keying the inlet/outlet valve buttons. Open channel 2 mass flow controller by keying the inlet/outlet valve button.

5. After five minutes, record the sampler flow rate under QA sampler on the audit data worksheet.

6. Record the transfer standard MFM reading on the audit data worksheet under the total flow column. (This will be used as Qind in Equation 1 of Section R.1.0.4 of this procedure.)

7. Close all valves by keying the appropriate inlet/outlet valve buttons. Shut the pump off by keying the pump button.

8. Complete the top half of the audit data worksheet with the required information, including ambient temperature (Ta), in degrees celsius, and ambient barometric pressure (Pa), in mm Hg. Under Sampler Calibration Data, record the calibration information for each mass flow controller.

R.2.1.3 POST-AUDIT CONFIGURATION

1. Disconnect the audit device from the sampler and return the sampling system to its previous operating condition.

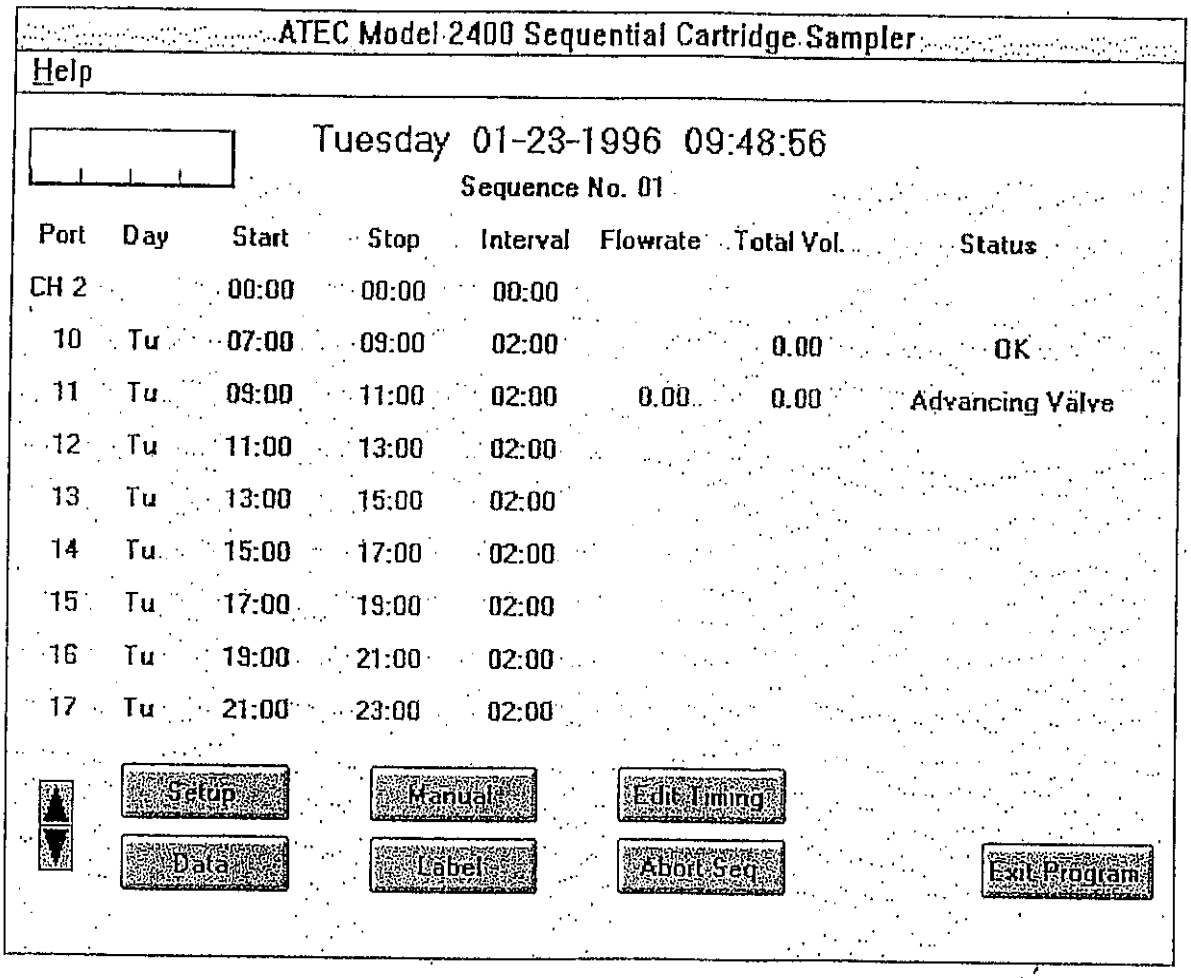

Figure R.2.1.1
Main Screen (ATEC Sampler Model 2400)

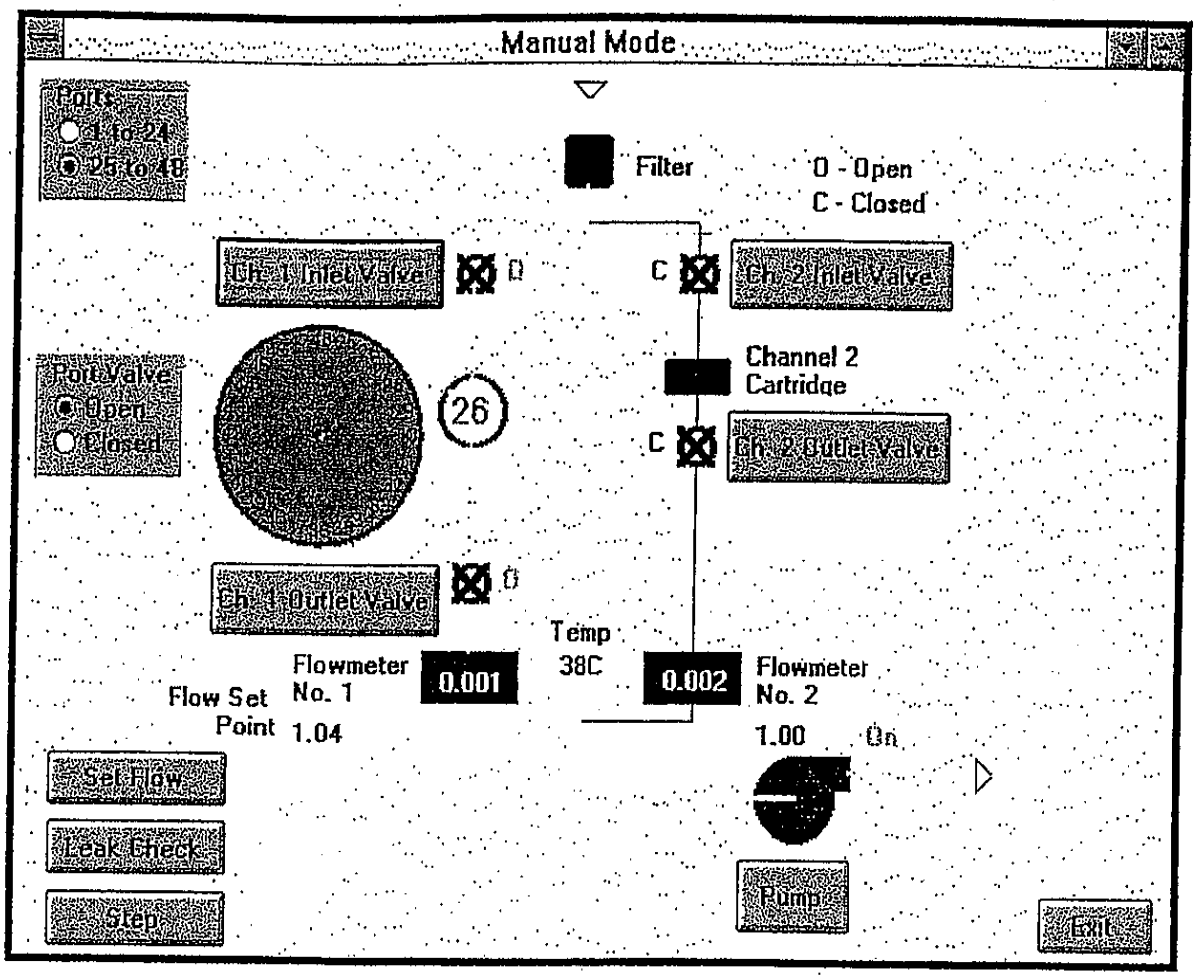

Figure R.2.1.2
Manual Mode Screen (ATEC Sampler Model 2400)